PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

George THORNE et al. Group Art Unit: 1725

Application No.: 10/813,395 Examiner: Not Yet Assigned

Filed: March 31, 2004 Docket No.: 119335

For: HIP MANUFACTURE OF A HOLLOW COMPONENT

CLAIM FOR PRIORITY

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The benefit of the filing date of the following prior foreign application filed in the following foreign country is hereby requested for the above-identified patent application and the priority provided in 35 U.S.C. §119 is hereby claimed:

United Kingdom 0307523.1 April 1, 2003

In support of this claim, a certified copy of said original foreign application:

☒ is filed herewith.

It is requested that the file of this application be marked to indicate that the requirements of 35 U.S.C. §119 have been fulfilled and that the Patent and Trademark Office kindly acknowledge receipt of this document.

Respectfully submitted,

James A. Oliff
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JAO:JSA/nxy

Date: August 23, 2004

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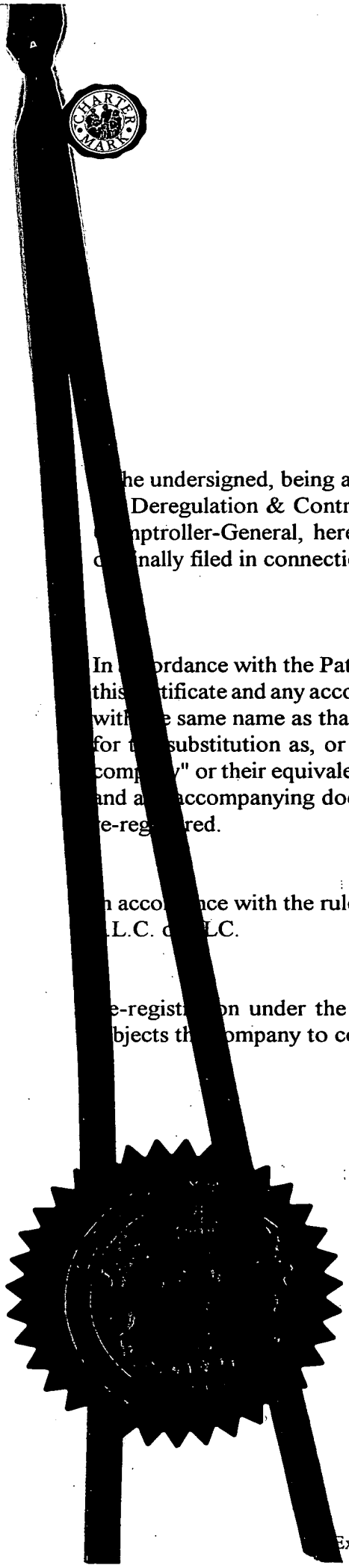

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

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Signed R. Mahoney

Dated 14 April 2004

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01APR03 E796881-1 D01097
P01/7700 0.00-0307523.1

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference PAT/GPW/3114

2. Patent application number *(The Patent Office will fill in this part)* 0307523.1 - 1 APR 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

ROLLS-ROYCE plc
65 BUCKINGHAM GATE
LONDON
SW1E 6AT
GREAT BRITAIN

Patents ADP number *(if you know it)* 3970002

If the applicant is a corporate body, give the country/state of its incorporation GREAT BRITAIN

4. Title of the invention HIP MANUFACTURE OF A HOLLOW COMPONENT

5. Name of your agent *(If you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

MR V J BIRD
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PO BOX 3
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BRISTOL
BS34 7QE

Patents ADP number *(if you know it)* 3970003

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

YES

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Continuation sheets of this form	0
Description	4
Claim(s)	1
Abstract	0 DL
Drawing(s)	1 0 4

10. If you are also filing any of the following, state how many against each item.

Priority documents	0
Translations of priority documents	0
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	NO
Request for preliminary examination and search *(Patents Form 9/77)*	YES ✓
Request for substantive examination *(Patents Form 10/77)*	NO
Any other documents *(please specify)*	NO

11. I/We request the grant of a patent on the basis of this application.

Signature V J BIRD Date 1 APRIL 2003

12. Name and daytime telephone number of person to contact in the United Kingdom

PAUL WALKER 0117 979 7416
paul.walker@rolls-royce.com

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Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.

b) Write your answers in capital letters using black ink or you may type them.

c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.

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DUPLICATE

HIP MANUFACTURE OF A HOLLOW COMPONENT

The present invention relates to the manufacture of a component using hot isostatic pressing (HIPing). In particular the present invention provides a method of manufacturing a nozzle for a gas turbine engine. In a preferred embodiment, the present invention provides for the manufacture of a nozzle for a gas turbine engine having an internal coating.

There is increasing interest in the use of two-dimensional, or "letterbox" type, nozzles for the exhausts of gas turbine engines. However, such nozzles are difficult to manufacture, typically requiring fabrication from a number of different elements. Such fabrication comprises the functionality of the nozzles by introducing regions of local weakness where welding is used to joint parts, or possible leakage paths where mechanical fastenings are used.

Another problem faced with two dimensional nozzles is the application of heat resistant coatings to their internal faces. Such heat resistant coatings, typically ceramic, are applied by Plasma Vapour Deposition (PVD) and enable an improvement in the performance of the nozzle. However, PVD is ill suited to the geometries of the two dimensional nozzles. Such nozzles typically have an aspect ratio of seven to one, with a height of, say, 150mm and concomitant width of 1m. As PVD guns typically have spray heads about 100mm high and require a stand off distance of about 1m, it will be understood that coating the internal surface of the nozzle is not possible using conventional PVD technology.

According to the present invention there is provided a method of forming a hollow structure for a gas turbine nozzle comprising the steps of placing a core shaped to form the internal surface of the structure in a mould, filling the mould with a material powder, hot isostatically pressing the powder about the mould, and removing the core from the hollow structure formed.

Preferably, the core is made of mild steel and removal is achieved by a chemical agent.

Preferably, a coating is applied to the core prior to placement in the mould.

Preferably, coating is a ceramic-metal mix, the proportions of metal in the coating varying from about 0% at the surface of the core to about 100% at the coating extremity.

The present invention will now be described in more detail according to the accompanying drawings, in which:

Figure 1 shows a core suitable for use in the present method of manufacture;

Figure 2 shows the core of Figure 2 with a coating;

Figure 3 shows the core placed in a mould;

Figure 4 shows the core and mould of Figure 3 filled with powder;

Figure 5 shows the use of the core and mould to hot isostatically press a part;

Figure 6 shows the consolidated part; and

Figure 7 shows the final part.

A mild steel core 2 is first machined with external dimensions which correspond with the desired internal dimensions of the open-ended hollow structure. It will be understood that although the illustration shows only a single cross-section of the core, its shape may be varied along the length of the finished structure.

Turning to Figure 2, a coating 4 is applied to the core 2. This coating 4 is, in essence, a mirror-image of the coating which is desired to be applied to the hollow structure 6

which is to be produced by the method. Hence, a hollow structure 6 for use as a gas turbine engine nozzle would typically have a ceramic coating bonded to the nozzle walls via a metal-ceramic bond coat whose composition varies across its thickness, from a near 100% ceramic content at the interface with the ceramic coating to a 100% metal content at the interface with the nozzle walls. Hence the coating applied to the core 2 comprises a ceramic coating in direct contact with the core 2, followed by a layer whose composition varies from 100% ceramic at the interface with the ceramic coating, to 100% metal at its outer surface. Preferably, this metal is of a similar thermal expansion to the material of the final hollow structure.

Turning to Figure 3, the coated mild steel core 2,3,4 is placed in a mould 8 whose internal cavity is of similar shape to the final product but of a slightly too large size. The reason for this will be disclosed further hereafter. A cavity 10 is defined between the core 2 and the mould 8. As shown in Figure 4, the cavity 10 is filled with powdered metal 12 such as, in the case of a gas turbine nozzle, a titanium alloy. This alloy 12 is packed into the cavity 10.

As shown in Figure 5, the outer mould is then compressed under a uniform pressure and at elevated temperature in a process known as hot-isostatic pressing. This process is well known and will not be described herein in further detail. Hot isostatic pressing of the metal powder 12 causes it to consolidate about the core 2. Furthermore the process consolidates the coating 4 onto the metal powder. Because of the bond coat, the coating 4 bonds preferentially to the core with a stronger bond than that between the coating 14 and the core 2. After the hot isostatic pressing, the mould 12 is removed to leave a hollow structure 6 having an internal coating 4, surrounding a mild steel core 2. The mild steel core 2 can then be removed by a process known as "pickling" in which a chemical agent such as strong nitric acid is used to leach the mild steel core out of the structure 12. The agent is chosen such that it does not substantially damage the ceramic coating 4. With the core 2 removed, a final hollow structure 12 with an internal coating 4 is left as shown at Figure 7.

It will be understood that where there is no need for an internal coating, the mild steel core can be left uncoated, and the powdered metal consolidated directly thereabouts. However, a selection of a suitable chemical agent will be more difficult, and it will have to be chosen so that it only dissolves the core and not the hollow structure. In such a situation it will be understood that it would be of benefit to make the core and structure of very different materials.

CLAIMS

1 A method of forming a hollow structure for a gas turbine nozzle comprising the steps of placing a core shaped to form the internal surface of the structure in a mould, filling the mould with a material powder, hot isostatically pressing the powder about the mould, removing the core from the hollow structure formed.

2 A method of forming a hollow structure as claimed in claim 1 wherein the core is made of mild steel and removal is achieved by a chemical agent.

3 A method of forming a hollow structure as claimed in claim 1 or claim 2 wherein the coating is applied to the core prior to placement in the mould.

4 A method as claimed in claim 3 wherein the coating is a ceramic-metal mix, the proportions of metal in the coating varying from about 0% at the surface of the core to about 100% at the coating extremity.

5 A method for creating a hollow structure as described hereinbefore and with reference to the accompanying drawings.

Figure 1

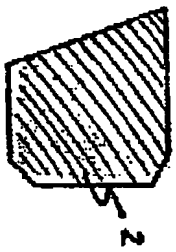

Figure 2

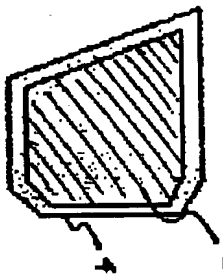

Figure 3

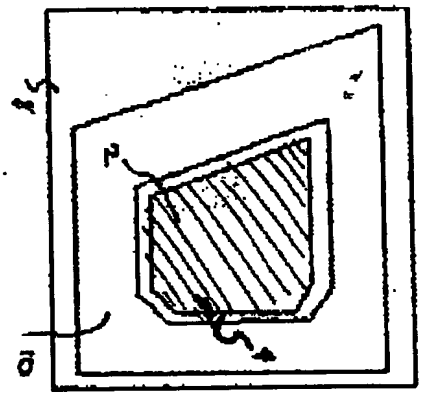

Figure 4

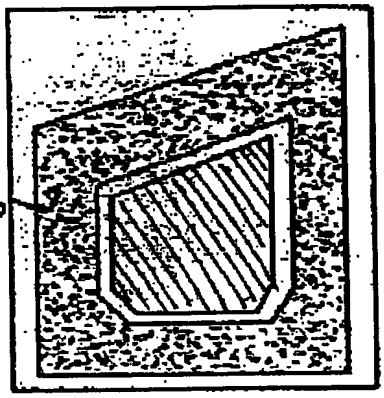

Figure 5

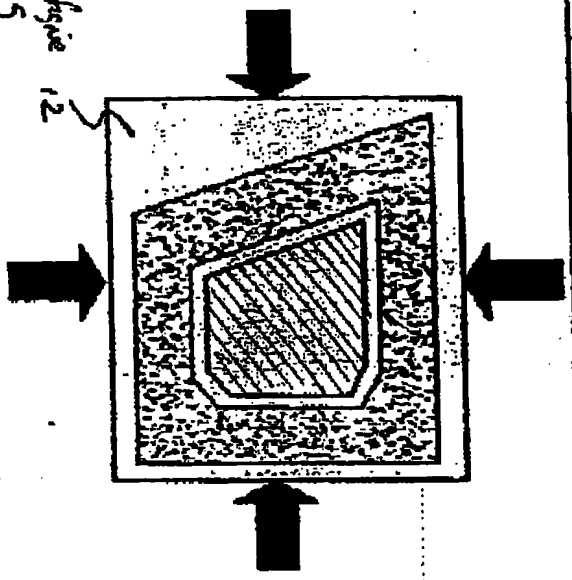

Figure 6

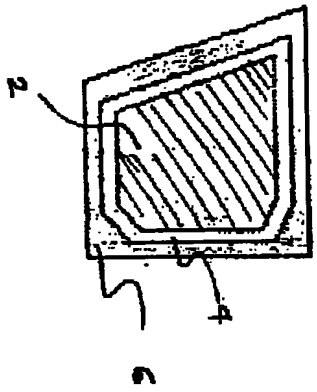

Figure 7